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ABSTRACT

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RELATIONSHIP OF TEACHER QUESTIONING AND STUDENT ANSWERING BEHAVIORS IN HIGH SCHOOL BIOLOGY AND CHEMISTRY CLASSES ACROSS THE SCHOOL YEAR

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ABSTRACT

This research assessed whether, within the context of a classroom session, the pattern of questioning and discussion used by teachers would be related to the pattern of student responses. Clear and comprehensible linkages between questioning and answering behaviors were found in this study. These results indicate that researchers can help resolve the complex questions about classroom transactions that face teachers and school administrators by using multivariate hypotheses and analytic methods without encountering some of the measurement problems inherent in the use of classroom observation data.

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Educational researchers have encountered considerable difficulty in describing classroom processes on the basis of observational data. In spite of decades of attempts to explain the relationship that we intuitively expect to exist between teacher and student behaviors in the classroom and outcomes, these relationships have not been adequately described. As a result researchers have been lead to develop increasingly complex observational schemes (Shavelson and Dempsey-Atwood, 1976). At times, our failure to develop an empirical description of classrooms has lead to the conclusion that our problem has been due to the measurement errors inherent in observational schemes (Erlich & Shavelson, 1978), while at other times it has lead us to conclude that the problem has not been appropriately conceptualized (Heath & Nielson, 1974; Rosenshine & Furst, 1971). In short, researchers have concluded that the quantification the teaching acts may result in unstable data and that most teaching behaviors may bear little relationship to student behaviors and, ultimately, to student achievement.

The failure to establish empirical relationships has reduced the impact of researchers on the resolution of such issues as the identification of master teachers, the improvement of teacher education programs, and the screening of teachers and teacher candidates with classroom observation schemes. If researchers

cannot demonstrate a relationship as simple as "different teacher behavior leads to different student behavior on the classroom level", they cannot be surprised if administrators and licensing agencies turn to standardized tests or anecdotal data to drive educational policy. What difference do variations in technique, training, or policies make, if most teaching acts are so unstable, unreliable, or ungeneralizable as to have no consistent relationship to student outcomes?

The purpose of this study was to test and explore the ramifications of a very straight-forward hypothesis: within the context of a single classroom session, the pattern of questioning used by a teacher will be related to a pattern of answers given by students. More generally, we sought to determine whether or not patterns of classroom observation data could be established in light of the generally accepted criticisms that observation data are unreliable, ungeneralizable, or conceptually flawed.

METHODS

Data from 258 high school biology and chemistry classrooms taught by 43 teachers in eleven school districts in central New York state were collected by means of audio tape recordings taken a six evenly-spaced intervals throughout the school year as part of a larger study. Three judges examined tapes and transcripts of a ten-minute interval from each class session and provided counts of the number of lines of discourse (interactions), the number of questions asked and answers given, the percentage of time a student's name was used by the teacher, the percent of

questions that were memory-recall, low convergent, high convergent, and evaluative, and the mean wait time #1 (time between asking and answering a question). The judges noted the percent of time answers were direct, inflected, the student "did not know the answer," and chorus, the mean number of words in the answer, and the mean wait time #2 (time between the end of the answer and the next discourse). These data were analyzed with a canonical variate analysis in order to establish the existence and strength of an overall relationship and to account for multiple patterns of relationships in the data linking questioning and answering behaviors.

RESULTS

The first statistical test was a test of the hypothesis of no significant correlation between questioning and answering behavior. This hypothesis was rejected (Wilks' lambda = 0.09177; F (63, 1340.90) = 11.242; $p < 0.001$; Canonical $R = 0.86$). Subsequent tests with successive roots removed, revealed no significant ($p < 0.05$) residual canonical residual canonical correlation after five pairs of canonical variates were extracted. The five significant canonical correlations in order of extraction were 0.86, 0.62, 0.53, 0.32, and 0.28. The standardized weights of each pair of significant canonical variates and the correlations between the canonical variates and the original variables are presented in Table 1.

The important elements of the vectors of questioning and

TABLE 1:

Canonical Correlation Analysis of Observed Teacher Questioning and Student Answering Behaviors

Canonical Variate Pair	1		2		3		4		5		
	w	r	w	r	w	r	w	r	w	r	
Question set											
N of lines	-.40	-.92	-.50	-.03	.19	.00	.03	.10	-.35	-.16	
N of questions	-.67	-.96	.22	.14	-.23	-.10	-.01	.08	.31	-.04	
% student named	-.08	.20	-.45	-.64	.36	.27	.49	.32	.72	.49	
% direct	-.54	-.16	4.62	.35	-2.92	-.38	-8.56	.48	4.21	.08	
% low convergent	-.46	.00	3.21	.07	-1.91	-.08	-6.56	-.55	3.36	.52	
% high convergent	-.42	.22	3.49	-.37	-2.06	.34	-7.02	-.00	2.83	-.54	
% divergent	-.21	-.03	.69	-.33	-.09	.56	-2.30	-.52	.69	-.10	
% evaluative	-.14	-.08	.81	-.15	-.39	.22	-1.59	-.07	1.07	.15	
Mean WT #1	-.01	.20	-.63	-.73	-.78	-.60	-.25	-.21	-.17	.02	
% Variance	21.31		15.19		11.89		10.80		9.62		Total = 68.80
Redundancy	15.78		5.84		3.29		1.12		0.77		Total = 26.80
Answer set											
N of answers	-1.01	-.99	-.17	.01	.12	-.09	.01	.07	.13	.11	
% Direct	.18	.15	.61	-.29	-.86	.27	-2.06	.01	1.50	.55	
% Inflected	.06	.09	.14	-.35	-.35	-.06	-.50	.45	.27	-.32	
% "Don't know"	.10	.10	-.05	-.32	-.40	-.12	-.57	-.05	.92	.55	
% Chorus	.08	-.21	1.01	.59	-1.06	-.28	-2.38	-.37	.82	-.47	
Words in answer	-.15	.14	-.38	-.55	.76	.59	-.55	-.53	-.30	-.19	
Mean WT #2	.03	.01	-.56	-.72	-.75	-.58	-.22	-.20	-.24	-.29	
% of variance	15.36		21.17		12.34		9.67		15.23		Total = 73.77
Redundancy	11.37		8.13		3.41		1.01		1.23		Total = 25.15
Canonical R	0.86		0.62		0.53		0.32		0.28		

answering behavior were:

PAIR 1: Many lines of discourse and many questions were related to many answers.

PAIR 2: A long mean wait time #1, high percentages of the use of a student's name, high convergent and divergent questions were related to a long mean wait time #2, longer answers, high percentages of inflected and "do not know" answers and a low percentage of chorus answers.

PAIR 3: A short mean wait time #1, high percentages of divergent and high convergent questions with little use of a student's name were related to long answers and a short mean wait time #2.

PAIR 4: A high percentage of low convergent and divergent questions with little use of a student's name were related to longer student answers, a high percentage of chorus answers, and a low percentage of inflected answers.

PAIR 5: A high percentage of low convergent questions, a low percentage of high convergent questions, and a high level of the use of a student's name were related to high percentages of direct and "don't know" answers and low levels of chorus answers.

DISCUSSION

The clear and comprehendible linkage between questioning and answering behaviors suggests that researchers may not be as impotent in the resolution of the complex issues that face teachers and school systems as we have believed. The problem may simply be that we have sought a single simple relationship to represent complex patterns of relationships within an instructional setting.

The high level of relationship between teacher questions and

students answers is encouraging because of the overlap in variation as well as the existence of five distinct patterns on linkage. From a methodological point of view, the most powerful relationship was trivial; namely, teachers who ask many questions have students who give many answers. This relationship accounts for most (70%) of the relationship. In a univariate observational scheme, this finding alone would be likely to lead a researcher to conclude that the most striking difference between classrooms was activity. Classes could be arranged on a continuum from inactive to active. In fact, the variance attributable to activity is so overwhelming, that, when directly observed in a classroom, it would probably obscure the other four patterns, which may be more directly related to the cognitive processing of students and the outcomes of instruction.

Classrooms high on the second variate pair were marked by the teacher asking personalized, high level questions calling for the solution or the generation of a set of solutions were related to lengthy answers with relatively high proportions of inflection and "don't know" with long pauses at the end of the answer. Such thoughtful experiences could be obscured by sheer activity, in spite of their obvious importance.

The third pair of variates seems to indicate the highly involved problem solving discussion so important in theories of science education. Here the teacher asked a divergent question or presented a problem. Students quickly suggested an lengthy answer and either the teacher or another student moved to a new

question or a new answer. The class was fast paced and impersonal, but involving.

The fourth pair appears to represent another variation of the classroom discussion. Many low convergent and divergent questions were asked by the teacher. Students responded with longer answers and chorus answers with few inflections. This suggested another form of discussion involving the group rather than an orderly progression of individual answers. Once again, students and teacher were involved with one another in a learning experience characterized by involvement.

The final pair seems indicative of the easily recognized drill or "quiz show" classroom where the teacher played the role of the "MC" asking many low level questions and few higher level questions, addressing the student by name. The student respondent either knew the answer and gave it or did not know and said so. Usually, the student who was addressed answered.

At the very least, these rather fragile forms of teacher-student interaction could be obscured by typical approaches to observing classrooms. They would probably not appear in the typical analysis of variance designs that have been used. The researcher, unimpressed by the poor linkage between mere activity and learning would be tend toward the conclusion that the data was flawed either by error or a lack of generalizability. A more complex multivariate hypothesis provides a greater likelihood of untangling the subtile complexities of classroom interaction. This application of canonical correlation analysis is one step

toward the development of a parsimonious description, while avoiding the temptation to oversimplify or to despair about the unidentified variances in our "infallible" measurements.

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